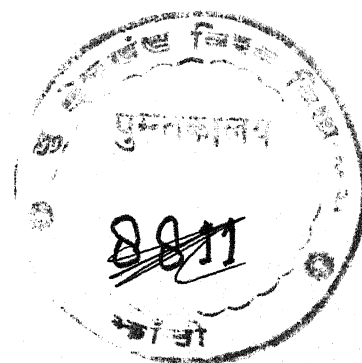


**A CLINICAL STUDY OF THE EFFECT OF
DIFFERENT ENDOTRACHEAL TUBES ON
THE INCIDENCE OF POST-OPERATIVE
LARYNGO-TRACHEITIS**

**THESIS
FOR
DOCTOR OF MEDICINE
(ANAESTHESIOLOGY)**



**BUNDELKHAND UNIVERSITY
JHANSI.**

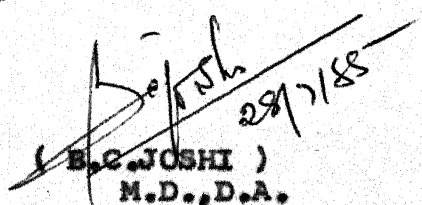
1986

PRADEEP KUMAR KHATTR

C E R T I F I C A T E

This is to certify that the work of Dr.
Pradeep Kumar Khattri on "A CLINICAL STUDY OF THE EFFECT
OF DIFFERENT ENDOTRACHEAL TUBES ON THE INCIDENCE OF
POSTOPERATIVE LARYNGOTRACHEITIS" which is being presented
by him for M.D.(Anaesthesiology) examination, 1986,
has been carried out in the department of Anaesthesiology.

He has put in the necessary stay in the
department as per university regulations.



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TUBES ON THE INCIDENCE OF POST-OPERATIVE LARYNGOTRACHEITIS"
which is being presented by Dr. Pradeep Kumar Khattri
for M.D. (Anaesthesiology) examination 1986, has been
undertaken by him under my direct supervision and guidances.
His observation and results have been checked and verified
by me from time to time.

He has put in the necessary stay in the
department according to the university regulations.

Dated: 31.. July, 1985.

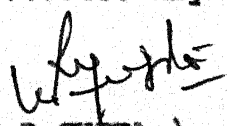

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M.D. (Anaesthesiology) examination 1986, has been carried out
independently by him under my direct supervision and
guidance. His observations and results have been periodically
checked by me.

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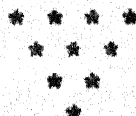
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I N T R O D U C T I O N

INTRODUCTION

Endotracheal intubation, although known as early as seventeenth century, is no doubt a boon to the present day ~~any~~ anaesthesiologists. No matter whether used for administration of anaesthesia or as a life saving procedure, in intensive therapy unit, this technique ensures a flawless respiration which is the chief concern of anaesthetist during anaesthesia and intensive therapy.

Apart from so many glittering advantages, that it provides, endotracheal intubation is also not unassociated with ⁸several major and minor complications and side effects. These side effects have been reported almost about a century after the introduction of this technique in clinical practice.

The so called postoperative "sorethroat syndrome" is still the problem and so many modifications in endotracheal tube design have been made by various workers now and then, without encouraging results. This syndrome, seen in the postoperative period is characterised by sorethroat, hoarseness of voice and difficulty in swallowing. True etiology to this problem has so far been eluding the anaesthetist, although several factors have been blamed as possible culprits. These factors which include infection, reaction to the material of tube, dry gases, local

anaesthetics, pressure of tubal cuff on tracheal wall, effect of humidification on inspired gases, effect of lubrication etc., have all been studied by various workers showing conflicting results. Even after so many improvement in endotracheal intubation technique and various modification in endotracheal tube design, the prevention of this problem has yet not been derived at conclusively.

Various workers have also studied the effect of nitrous-oxide diffusion into endotracheal tube cuff and found over-expansion of cuff due to diffusion of nitrous-oxide into cuff leading to increase cuff tracheal contact area, causing enhanced incidence of postoperative sorethroat. Several workers have given different methods to eliminate this problem of nitrous oxide diffusion into cuff.

Effect of lubrication of endotracheal tubes on the incidence of postoperative sorethroat is also contraversial. Different workers have given different views about the effect of lubrication on the incidence of postoperative sorethroat. It is only a mechanical advantage that lubrication provides, while others says about the effect of local anaesthetic that the lubricants contain in it. So varying are the results about the effect of lubrication on the incidence of postoperative sore-throat, that it becomes genuine to study the effect of the same.

Minimum study is carried out about the effect of tube on the incidence of postoperative sorethroat. Various workers have given conflicting results about the effect of

material of tube on the incidence of postoperative sorethroat, so it is also included in the present study.

Same is the situation about the effect of type of cuff on the incidence of postoperative sorethroat. Various workers have given different views about type of cuff to be used to minimise the incidence of postoperative sorethroat. Whether cuffed tube increase^s or decrease^s the incidence of postoperative sorethroat, is also contraversial. So effect of cuff on the incidence of postoperative sorethroat is included in the present study.

There is also not so extensive study of type of inhalational agents used during anaesthesia, on the incidence of postoperative sore throat. But Ether is taken as agent used in the present study to eliminate the variable of type of inhalational agents used. Some workers have studied and given results that incidence of postoperative sorethroat is maximum when ether is used as sole inhalational agents.

To summarise, the basic aim of the present study is to look into the following factors, as to how they affects the incidence of postoperative sorethroat -

1. Endotracheal tubes made up of different material.
2. Lubrication.
3. Cuffed tubes & plain tubes.

REVIEW OF LITERATURE

Endotracheal intubation has firmly established its place in modern anaesthetic practice and also in resuscitation. Time and again various workers have reported changes in larynx and trachea, both micro and macro-scopic after a long intubation period.

Laryngeal complications of endotracheal anaesthesia are divided into major and minor groups by Wolfson (1958) who presents a complete review of the literature on both major and minor sequelae.

Briefly major sequelae include granuloma formation, contact ulcer, subglottic membrane, subglottic oedema, tracheitis, haemorrhage of vocal cord, oedema of cord, larynx or trachea, Paralysis of vocal cords and perforation of trachea or oesophagus. Case reports of granuloma formation and contact ulcer appear most frequently in the literature, whereas the other complications are bizzare and unusual.

Minor complications of endotracheal anaesthesia are, on the other hand of common place occurrence. Minor sequelae reported in several series include mild and severe sorethroats, hoarseness, pain and difficulty in swallowing, pharyngeal ulceration and aphonia.

HISTORY

C. Kite of Gravesend described oral and nasal intubation for resuscitation of the apparently drowned in 1788. Intubation from the neck, through a tracheostomy wound, was performed in 1858 by John Snow in anaesthetizing animals. Trendelenberg (1844-1924) used the method in man in 1871, occluding the trachea by an inflatable cuff.

Wm. Mac Ewen of Glasgow in 1878 passed a tube from the mouth into the trachea, using his fingers as a guide in the conscious patients. Karl Maydl of Prague employed the tube of Joseph P O'Dwyer of Cleveland, designed for the treatment of laryngeal diphtheria in anaesthesia (1893).

In 1907 Bathelemy and Dufour of Nancy, France used insufflation endotracheal technique in men using chloroform. Elsberg & others in 1909 applied. in-sufflation endotracheal anaesthesia by tube in man.

Alfred Kirstein of Berlin and Gustav Killian of Freiberg - The original bronchoscopist-Pioneered direct laryngoscopy in 1895 and 1912 respectively and chevalier Jackson of Philadelphia published a book on the subject in 1907. This popularized direct laryngoscopy. First blind nasal intubation was performed by Stanley Rowbotham of London (1920).

Inflatable cuffs have been used for many years, but were reintroduced by waters and guedel in 1928.

A pilot balloon was described in 1893 by Eisenmenger and was reintroduced by Langton Hewer in 1939.

Before the days of muscle relaxants, blind nasal intubation was very popular as it was usually quicker than direct vision oral intubation when intubation agents were all that were available. Indirect laryngoscopy with a laryngeal mirror was pioneered by Manuel Garcia, a teacher of singing in London in 1855.

In recent years the attitude to intubation has altered radically because the use of muscle relaxants and especially the use of suxamethonium has made intubation relatively easy, quick and atraumatic.

The use of muscle relaxants has greatly increased the need for intermittent positive pressure ventilation and this is more satisfactorily carried out if the patient is first intubated.

ENDOTRACHEAL TUBES - The traditional tubes are the wide bore Magill tubes of mineralized rubber. They can be used for either nasal or oral intubation, the latter having thicker walls. The number of tube corresponds to the internal diameter of ⁱⁿ millimetres. Other tubes are made of semirigid material. The portex plastic tube (Polyvinyl chloride) being useful (Eustac B.R. et al 1969).

Another type of tube is made of a spiral coil of nylon embedded in latex to prevent kinking (Hollinger T.H. et al 1944). The oxford or inverted L-Shaped tube (Allop A.F. 1955), has two limbs which are shaped to the passage from the mouth to the trachea and so can not Kink, even when the head is fully flexed. Its internal diameter is the same throughout but the thickness of that part which lies in the mouth and pharynx is twice that of distal part. The tube can be passed between the cords as it is or else on a curved stylet or a long gum elastic introducer. Inflatable cuffs can be incorporated with the tubes.

Tubes should be cleaned with soapy water outside and inside with test-tube brush. Heating to 75°C for 10 min. (Pasteurization) will Kill vegetative organisms which are potentially harmful, although relatively harmless spores will not be Killed. Rubber tubes can be autoclaved upto six times without much deterioration. Disposable tubes are very costly for use. Tubes may be supplied already sterilized by gamma ray . Tubes can be dipped in Glutaraldehyde (Cidex 2%) for 30 min., for sterilization after cleaning.

INFLATABLE CUFF - Tubes, with internal diameters in the larger sizes can be supplied with inflatable cuffs.

Cuffs are used to ensure air tight tracheal anaesthesia instead of pharyngeal gauze packing. The Hewer pilot balloon shows the state of the cuff. When it is hidden in the trachea. There is the danger, when using the cuff, of causing sloughing of tracheal mucosa. The pressure in the cuff when comfortably inflated may be 120-180 mm of Hg but this does not correspond to the pressure applied to tracheal mucosa.

Cuffs should not be inflated to a pressure greater than that needed to prevent audible leakage of gas when the reservoir bag is compressed.

Various cuffs exert different pressures (Mackenzie C.F. et al 1976). The integrity of inflatable cuffs must always be tested before use. Separation of cuffs at their margin has been reported, leading to leaks. Nitrous Oxide has the ability of diffusing into air inflated latex cuffs and may thus cause over expansion and trauma to mucosa (Stanley T.H. et al 1974).

As cuffs prevent leakage between the wall of the trachea and outer wall of the tube, they are useful in intermittent positive pressure ventilation. They also prevent gastric contents, blood, mucus and vomitus from entering the lungs and so are essential in intestinal obstruction with regurgitant vomiting and in operation

on the upper air passage.

LUBRICANTS - To intubate atraumatically, the tube and laryngoscope should be smeared with either a greasy or water soluble lubricant. A local analgesic can be incorporated such as lignocaine 2-4% while soft yellow paraffin is the better lubricant for blind nasal intubation, its water soluble substitutes will not cause Pneumonitis, if they reach the lungs. An analgesic - containing lubricant will increase tube tolerance and reduce the incidence of extubation spasm after short operations. Solutions and viscous are better than jelly.

HISTORY OF POSTOPERATIVE SORETHROAT

In 1950 Wylie found in a series of 100 patients that 70 patients complained of sorethroat upon direct questioning. In 1951 Baron and Kohlmoos two Otolaryngologists reported that everyone in a series of 80 patients complained of a mild sorethroat lasting at least 24 hours following endotracheal intubation. In 1958 Wolfson, in a review of 521 patients, found that 18.4 percent complained of sorethroat when questioned directly. In 1960 Conway and his groups found in 642 patients that incidence of sorethroat was 38.2 percent when the patients were questioned directly. Hortsell et al (1964), reported that postoperative sorethroat in 400 patients as 5.7 percent.

Loeser et al (1976). LoeserMachih et al (1978a) reported sorethroat and hoarseness in 24-65 percents of patients intubated with cuffed tubes.

Various factors have been blamed for postoperative sorethroat.

POSTOPERATIVE SORETHROAT

DEFINITION AND CLINICAL FEATURES - A patient was considered to have a sorethroat if he complained of this either spontaneously or upon enquiry, postoperative sorethroat syndrome consists of scratchy feeling in throat, loss of voice, hoarseness and stridor. Sorethroat may be divided into mild or severe. A mild sorethroat was arbitrarily defined as one which lasted for one or two days only, unaccompanied by loss of voice or hoarseness or stridor. A severe sorethroat was defined as one which was accompanied by loss of voice or hoarseness or stridor or one which lasted for three days or more (Comsaw C.M. et al 1960).

FACTORS INFLUENCING INCIDENCE OF SORETHROAT - True etiology to this common problem has so far been eluding the anaesthetists, although several factors have been blamed as possible culprits. These factors include infections, reaction to the material of tube, dry gases, local

anaesthetists, lubrication, pressure of tubal cuff on tracheal wall etc. contributory factors which can lead to incidence of postoperative sorethroat syndrome include- unsterilized endotracheal tube, traumatic laryngoscopy, pharyngeal airway, Pharyngeal throat gauze packing, Ryle's tube, type of muscle relaxants used for intubation, skill of anaesthetist, difficult intubation, extent of movement of patient's head after in-tubation type of lubricant used on endotracheal tube, single or repeated application of lubricant, sex.

SEX - There is higher incidence of sorethroat in females (Wolfson 1958, Hortsell & Stephen 1964, Jensen et al 1982, Shah & Mapleson 1984), Gard & Cruickshank (1961), noted higher incidence in woman (56%) as compared with men (33%). Wolfson (1958), reported in 26.9% of females and 14.9% of males. Wolfson noted this due to higher incidence of contact ulcer and granuloma formation in the female. Jensen et al showed that women were more likely to develop sorethroat after intubation than men, a possible relationship between differences in cuff-trachea contact area is postulated.

Hortsell and Stephen (1964), noted complaint of sorethroat three time more frequently in females than in males. Conway et al (1960), found no difference

in male and female on incidence of sorethroat.

NASOGASTRIC TUBE - Conway et al (1960), found that sorethroat occurred twice as often in patients in whom a nasogastric tube was utilized. Gard and Cruickshank (1961), reported effect of Levin tubes on incidence of sorethroat, with Levin tubes 48% and 43% without Levin tubes had complaints, he further noted that trauma due to oesophageal tubes does not become severe enough to cause symptoms until second or third day post-operative and becomes progressively worse after that time. Hortsell and Stephen (1964), reported that incidence of sorethroat was doubled when nasogastric tube was employed.

However Hortsell and Stephen (1964), further noted in a small series of patients who were anaesthetized by mask only, with nasogastric tubes in place and found no complaints of sorethroat and he further noted effect of nasogastric tube on incidence of sorethroat, as etiological factor is not clear.

TRAUMA - Trauma at the time of intubation often is believed to be related to development of sorethroat (Hortsell and Stephen 1964), Trauma may be produced by laryngoscope or by manipulation of endotracheal tube in difficult intubation. Hortsell and Stephen noted that traumatic intubation did not increase the incidence of sorethroat significantly.

COUGHING AND BUCKING - Sorethroat developed almost twice as frequently in patients who had bucking episodes with the endotracheal tube in place (Hortsell and Stephen 1964), same author further reported no cause and effect relationship in this respect.

TOPICAL ANALGESIA - Conway (1960), found no difference when a topical an^lgesic was applied. Gard and Cruickshank (1961), reported that a local spray to the larynx before intubation did not appear to alleviate sorethroat, but it did make far smoother anaesthesia, as it prevented bucking movements at the time of onset of the operation, before the lubrication had time to work. Hortsell and Stephen (1964), reported an increase in incidence of sorethroat among the group who received topical analgesia. They had given no explanation for the finding. They further noted that incidence of sorethroat was greater when the anaesthetic gas applied by transtracheal route than when it was instilled directly into the trachea in an atraumatic manner through the larynx.

PHARYNGEAL GAUZE PACKING - Conway et al (1960), noted that in^ysertion of gauze pharyngeal pack moistened with water was associated with a high incidence of sorethroat.

MUSCLE RELAXANTS - Conway et al (1960), reported that there was not statistically significant difference between incidence of sorethroat after suxamethonium and that after gallamine tri-ethiodide and tubocurarine. They further reported a trend toward a greater frequency of sorethroat after suxamethonium and lesser frequency after gallamine. They have given possible explanation for this is that the relaxation provided by gallamine unlike suxamethonium does not wear off rapidly and thus does not expose a lightly anaesthetized patient to the risk of bucking on at endotracheal tube. The increased incidence of sorethroat after suxamethonium may be a part of muscle pain syndrome (Conway et al 1960), Gallamine might be expected to provide slightly better intubating conditions than d-tubocurarine as its onset of action is more rapid.

Capan and Colleagues (1983), have shown a much higher incidence of sorethroat when suxamethonium was used than when it was not, in female patient who were not intubated and not paralysed with a non-depolarizing neuromuscular blocking drug.

But Shah and Mapleson (1984), showed no marked difference between suxame-thonium group of patient on

incidence of postoperative sorethroat and deduced that striking difference from the results of Capan and co-workers (1983), must be attributed to some difference in experimental or patient population-transatlantic differences in response to neuro-muscular blocking drugs (Katz et al 1969).

POSITION AND HEAD MOVEMENT - Gard and Criuckshank (1961) reported that of their patient, only 43% ^{had} sorethroats when there had been little or no head movement, whereas 58% ^lcompained when there had been frequent head movement and 53%, when the patient had been turned to prone position.

DIFFICULT INTUBATION - Among the commaner cause of difficulty of intubation case a bull neck, prominent incisor teeth, a stiff neck and laryngeal and masseter spasm. Conway et al (1960), found no increased incidence of sorethroat with these factors.

EFFECT OF LUBRICATION - Practical aspect of lubrication of endotracheal tube is important and it is studied by Gard and Cruickshank (1961), they have shown that creams are generally more desirable then jellies, because jellies tend to dry out quickly and become hard and sticky on the endotracheal tubes when applied any length

of time prior to operation. Cream persist roughly 30 to 50 minutes and jellies 15 minutes. Some authors have also studied about the influence of the various types of lubricants and their single or repeated application on incidence of sorethroats following intubation.

Gard and Cruickshank (1961) have shown that lowest incidence of complications occurred with one application of pramoxine cream that is 35% as opposed to 43% pramoxine jelly, 54% for K-Y jelly. The 38% incidence of complications with repeated use of K-Y jelly is probably not significant according to same authors because of the small number of cases involved. According to Gard and Cruickshank repeated lubrication to overcome the piston action of the endotracheal tubes did not significantly lower the incidence of sorethroat except with K-Y jelly when the percentage dropped from 54% to 38% on repeated application.

Conway et al (1960) reported that use of local analgesic or other lubricants on the tube did not alter the incidence of sorethroat except in the case of Cinchocaine ointment which was associated with the high incidence of sorethroat. They further reported that this may be due partly to the greasy base of the preparation used, which

might dissolve some irritant substance ^{from} the rubber of endotracheal tube.

But Winkel and Knudsen (1971) have shown that patients might benefit from lubrication of tracheal tubes with 1% Cinchocaine jelly.

According to Jensen et al (1982) Lubrication of tracheal tubes provides no advantage in terms of reducing sorethroat after operation.

Loeser, Stanley et al (1980) reported that lubrication with 4% lighocaine jelly containing polyethylene and propylene glycol was associated with increased complaints after operation.

Christine Stock and Downs (1980) studied effect of lubrication of endotracheal tubes with many lubricants which include-water soluble jelly, normal saline solution, lidocaine 2% jelly and lidocaine $1\frac{1}{2}\%$ ointment. They concluded that patients who received lubricated tubes complained of sorethroat and hoarseness to the same extent as those who received non-lubricated tubes. In addition the presence of lidocaine in the endotracheal tube did not alter the incidence or severity of sorethroat or hoarseness when compared with those who received tubes prepared with lubricants and which did not contain lidocaine.

Lund and Daos (1965), found the incidence of sorethroat significantly decreased with a viscous lidocaine ointment compared with less viscous lubricant with or without local anaesthetic agents added.

Therefore investigators who used reusable rubber latex or plastic tracheal tubes did not agree in their quest for a lubricant that would consistently decrease the occurrence of sorethroat.

Loesser and co-workers (1980), reported that compared with non-lubricated cuffed endotracheal tubes uncuffed lubricated endotracheal^{tracheal} tubes provide no advantage in decreasing incidence of sorethroat. However these investigators did not examine the incidence of sorethroat complained when cuffed endotracheal tubes were lubricated.

Christine and Stock (1980), found no significant difference in incidence or severity of sorethroat based on the type of lubricants used on tracheal tubes or based on the presence or absence of lidocaine in the lubricant. Infact they reported that there was no difference in the incidence or severity of sorethroat in patients who were intubated with dry tubes compared with those intubated with lubricated tubes.

Many investigators have reported that intubation was mechanically easier when some form of lubrication was applied to the tube.

DEFINITIONS - Cuffs mostly used in anaesthesiology are built-in the and slip-on cuffs.

RESIDUAL VOLUME - The amount of air which can be withdrawn from the cuff after it has been allowed to assume its normal shape in the natural intratracheal position with the inflation tube exposed to atmospheric pressure.

CUFF INFLATION VOLUME - The volume added to residual volume to abolish leak during IPPV.

INTRA CUFF PRESSURE - Pressure measured at the stated cuff inflation volume using Statham p-23-H Transducer (fluid filled) connected to the cuff inflation tube (air filled) via a three way stop cock.

TRACHEAL WALL PRESSURE - Pressure exerted laterally by the cuff on the head of an oil filled extension of Statham p-23-H pressure transducer which was implanted in the anterior tracheal wall.

SLOPE PRESSURE - The tracheal wall pressure produced in by inflating the cuff, 1ml beyond the no leak inflation volume.

EFFECT OF CUFF - Conway et al (1960), noted high incidence of sorethroat, when non-cuffed tubes were used. They have given a possible explanation for this is that the inflated cuff anchors the tube in the trachea, so that movement of

the tube relative to the trachea is unlikely to occur. Non-cuffed tubes may move freely in the trachea, larynx and Pharynx in response to movement of the patient's head or to respiratory movement.

According to Kamen and Wilkinson (1971) direct pressure from a distended balloon on the tracheal wall is the major etiologic factor in tracheal injury. The length of time, over which the pressure is maintained, contributes to the severity of injury. The safe pressure that the cuff may exert against the tracheal wall is a pressure that does not obliterate capillary blood flow that is less than 20mm of Hg. Tracheal cuffs in common use are not satisfactory for long-term application because of the excessively high pressure needed to produce an air tight seal.

Cooper et al (1969), showed that a standard cuffed endotracheal tube inflated to a point which prevented air leakage while a patient was ventilated at 20-25cm H₂O had intraluminal pressure of 180-250mm of Hg and c-t pressure of 200mm of Hg.

Foam filled cuff of Kamen and Wilkinson (1971), exert pressure against tracheal wall less than those necessary to produce tissue necrosis and it is atraumatic and can be used in full stomach because cuff is rapidly self-inflating when the negative pressure is released.

Stanley et al (1974), reported that Nitrous-Oxide has the capacity to diffuse into the latex rubber endotracheal tube cuff in significant volumes and suggest that such diffusion may result in over-expansion of the cuffs and cause upper airway obstruction and trauma in intubated patients.

According to Tenney et al (1953), and Eger and Saidman (1965), have shown that an enclosed gas filled space in the body will expand if it contains a gas (nitrogen) which is less soluble in blood than the gas respired (Nitrous-Oxide).

An air inflated endotracheal tube cuff within the trachea represents a gas filled pocket in the body.

Stanley et al (1974), reported that Nitrous-Oxide diffuses in to cuff of latex endotracheal tube, same author also have quantitated the cuff volume changes and rates at which they occur during exposure to various concentration of nitrous oxide.

Both Tenney et al (1953), and Eger and Saidman (1965), reported that two main factors govern the rate at which increase in volume take place in gas enclosed space in the body.

1. The rate increases when the blood flow to the space or the blood flow space volume ratio increases.

2. The rate increases as solubility of respired gas in the blood increases.

Other factors which influences rate^{cf} diffusion through a semipermeable membrane and might effect the rate at which nitrous-oxide or any other respired gas moves into an enclosed gas filled space include -

- Temperature
- Gram molecular weight of respired gas
- Its permeability through or solubility in the tissue making up the wall of the space.

- The pressure differential of the respired gas across this wall

Stanley et al (1974), reported that cuff wall thickness, partial pressure difference of nitrous-oxide and oxygen across the cuff wall and possibly the solubility of these gases and nitrogen in latex rubber are the most important determinant of rate of gaseous diffusion into and out of latex rubber air filled endotracheal tube cuff.

Stanley et al (1974), further reported that endotracheal cuff volume changes were directly related to the partial pressure differences of nitrous-oxide across the wall of the cuff. They further noted that although less diffusible than nitrous-oxide, oxygen also contributed to

an increase in endotracheal tube cuff volume when its concentration gradient across the cuff wall was high (75% out side the cuff versus 20% inside). When lower concentration of oxygen were used that is 50% passage of oxygen into the cuff was negligible less than 1mm in 4 hours. Nitrogen diffusion was the least of these gases studied.

Stannett and Szwarc (1955), has shown that oxygen is 3-4 times more diffusible than nitrogen through most polymer membranes.

Barrer et al (1958), has shown that the process of permeation of gases through a plastic or rubber membranes occur as a sequence of three phenomena -

1. Absorption and solution of the gas into the membrane at the one surface.
2. Diffusion of gas through the body of the membrane.
3. Dissolution and freeing of the gas from the membrane at the other surface.

According to Stanley et al (1974), at least one of these phenomena is impaired in the diffusion of Nitrogen as compared with Nitrous-oxide, through standard latex rubber endotracheal tube cuffs.

Stanley et al (1974), have shown that intra-cuff pressure below 100mm. Hg have not been shown to result in lateral tracheal wall pressure above normal systolic

arterial blood pressure and therefore probably do not cause enough tracheal wall compression to produce tissue ischaemia.

Stanley et al (1974), reported that nitrous-oxide would appear to be a better cuff inflating gas than air or if room air were used, it would be important to deflate cuffs periodically in order to avoid build-up of endotracheal tube cuff volume and pressure during nitrous-oxide anaesthesia.

Stanley (1975), further studied the diffusion of nitrous oxide into cuffs. He found that 76 to 88% of the measured cuff volume changes were the result of diffusion of nitrous-oxide into cuff, while 2 to 10% were due to diffusion of oxygen. Such over expansion of cuff may be an important cause of tracheal or laryngeal trauma and post-operative sore throat in patients whose trachea have been intubated. Nitrous-oxide diffuses less rapidly through latex rubber than through PVC. He further reported that both high pressure and low pressure air filled endotracheal tube cuff sustain significant increase in cuff volume and pressure after exposure to nitrous-oxide and oxygen. While low pressure cuffs have lower initial and final cuff pressures than high pressure cuffs, pressure and volume changes are similar with two

and primarily caused by diffusion of nitrous-oxide into the cuffs.

Stanley (1975), noted that cuff volume changes are less invivo than invitro. One reason for less diffusion of nitrous-oxide invivo is that less cuff surface area is available for diffusion. Only inferior portion of cuff, the portion not in contact with the tracheal wall is exposed in inspired gases in intubated patients. Other reason for less diffusion of nitrous-oxide into cuffs, invivo than invitro, are higher initial and subsequent cuff pressure in the invivo study, resulting from tracheal wall restriction of cuff expansion. Increased cuff pressure must result in proportional increase in the partial pressure of all gases within the cuff. This tend to decrease the pressure gradient across the cuff wall for any nitrous-oxide in the cuff and increase it for nitrogen, both of which hinder cuff volume expansion.

EFFECT OF TEMPERATURE ON NITROUS-OXIDE DIFFUSION

Stanley (1975), studied this, using distensible cuffs in his study, it is reasonable to assume that at least small component of both pressure and volume changes observed from inflation to deflation reflected an increase of cuff gas temperature. If the temperature of the cuff gases

were 20°C at the inflation and 37°C after a few minutes within the cuff, according to Gaylussac's law the maximum increase in the cuff pressure due to temperature change would be 17/273 or approximately 6% of the pressure at the initial inflation. But all cuffs studied (Stanley 1975), not possessed fixed volume as the above gas law require, the amount of increase of cuff pressure caused by temperature change must have been significantly less than 6% is in the same reasoning and Charles's law, volume changes resulting from increase in temperature of cuff gases after initial inflation must also be negligible.

Stanley et al (1978), studied various physical characteristics of cuffs on which diffusion of nitrous-oxide into cuffs depend. They noted that diffusion rate into most cuffs varied inversely with cuff thickness and directly with the partial pressure of the nitrous-oxide. They have noted that Kamen-Wilkinson silastic cuffs was more permeable to nitrous-oxide than PVC cuffs.

The inflatable cuff should provide both airway seal during positive pressure ventilation and protection from aspiration without causing significant trauma to trachea. A ⁸various practical dilemma exists because lateral wall pressure adequate to maintain tracheal seal may decrease or eliminate capillary flow in the lamina propria and cuff

to trachea pressure that permits capillary flow, may also permit gas leak and/or aspiration.

Stanley et al (1978), reported in experimental study chamber that cuff volume increases after exposure to nitrous-oxide varied with exposure time, cuff thickness, nitrous-oxide tension and cuff composition.

They further reasoned (1978), that intra cuff volume and pressure changes after nitrous-oxide anaesthesia can be minimized by filling the cuff with inhaled anaesthetic gases or using a low cuff pressure regulating device.

Furthermore they recommend in 1978, the desirable cuff characteristics to be as follow :-

1. Tear resistance.
2. Thin wall
3. Larger diameter
4. Large enough residual volume to "buffer" positive intra tracheal pressure.

Intracuff pressure during extubation in large diameter air inflated cuffs be controlled at "safe" level using a pressure regulating devices. Cuff pressure may also be manually adjusted to a "safe" level with a syringe and accurate manometer. Filling large diameter cuff with the anaesthetic mixture during nitrous-oxide anaesthesia is an alternate method to maintain the intra cuff pressure constant.

CUFF TRACHEA CONTACT AREA, HIGH VERSUS LOW VOLUME CUFFS

Stanley et al (1978), observed that high residual volume, high tracheal contact cuffs, caused markedly higher incidence and greater severity of post operative sorethroat than low residual volume, low tracheal contact cuffs.

Kamen - Wilkinson tubes with high residual volume cuffs also increase the incidence of post operative sorethroat. Thus tubes with high residual volume provide no advantage for short, term tracheal intubation as required for most operations.

Same author reported that cuff-tracheal contact area is an important factor in the development of post-operative sorethroat.

Loesar et al (1980), reported the same findings. They reported that incidence and severity of post-operative sorethroat is highly correlated with the length of cuffs used on endotracheal tubes but not with intubation time, age of patient, type of operation or intracuff pressure. They reported that while large volume, low pressure, endotracheal tubes cuffs produce less average depth of tracheal mucosal erosion after approximately 6 hours of endotracheal intubation than do low volume, high pressure cuffs, tracheal erosion produced by former is evidenced over a much larger area of tracheal mucosa than that of latter.

Further, Loesar et al (1980), found that many large volume low pressure cuffs correctly manufactured wrinkle inspite of proper inflation and wrinkles result in a deep mucosal grooves.

A minor role of cuff pressure per se, was further reported in a study confirming that the frequency of post-operative sorethroat after tracheal intubation with high residual volume low pressure cuff is independent of cuff filling with a sample of the inspired mixture of gases, room air or saline (Stanley and Loesar 1979). Although the minor role of pressure seem to be established, it is known that cuff inflation beyond the seal point significantly increases the measured intra cuff lateral wall pressure and therefore possibly the cuff tracheal contact area too (Wu et al 1973).

Erikensen, Jensen et al (1982) reported that a low volume high pressure cuff induced sorethroat to a lesser extent than did high volume low pressure cuffs, provided that intra cuff volume were maintained at the level of just "seal" throughout anaesthesia, when intra cuff pressure in low volume high pressure cuffed tube was high and allowed to increase, this advantage disappeared.

In the study of Loesar et al (1978), it was shown that small resting diameter, small residual volume, low

tracheal contact, high pressures cuffs caused sore throat less often than did large resting diameter, large volume cuffs.

Based on cuff tracheal contact area Jensen and Erikensen (1982) showed that women were more likely to develop sorethroat after intubation than men because there is much cuff tracheal contact area in women than in men.

Shah and Mapleson (1984), have shown negligible effect of intermittent adjustment of cuff volume, they alongwith Jensen and Colleagues (1982), have shown 80 or more patients in each group with incidents of 44% with adjustment and 46% without, a difference of -2% with approximate confidence limits of this difference -17% and +13% (Glantz 1981).

As mentioned above several previous studies (Loesser et al 1976, 1978, 1980, Jensen et al 1982) have compared "standard" high pressure low volume cuffs such as those on red rubber tubes (intra cuff pressure 30 to 40 KPa) with "floppy" low pressure high volume cuff (intra cuff pressure 2 to 3 KPa). These studies have consistently found a higher incidence of sorethroat with low pressure cuffs. Pooling the results of all four studies (Shah and Mapleson 1984) gives over 300 patients in each group with incidence of 56% and 29% a difference of 27% with approximate 95%

confidence limits of 20% and 35%.

MATERIAL OF TUBE - Shah and Mapelson (1984), have shown that the PVC (portex blue line) tube has an intermediate intracuff pressure of above 7 to 9 KPa and might therefore be expected to give intermediate results. However data of Shah and Mapelson (1984) shown a non-significant lower incidence with PVC tube than with red rubbers tubes. Whereas Jensen and colleagues (1982), found nonsignificant higher incidence. Combining the compressed "direct" scores of Shah and Mapelson (1984) with result of Jensen and colleagues, Shah and Mapelson (1984), have shown that it gives a total of 80 or more patients in each group with incidence of 45% red rubber, and 49% with PVC. This is a 4% greater incidence with the PVC tubes but with approximate confidence limits of 12% lesser to 19% greater.

EFFECT OF HUMIDIFICATION - Shah and Mapelson (1984), have shown the effect of humidification of inspired gases on incidence of postoperative sorethroat. They have shown incidence of 40% with humidification and 42% without with "direct scores", a difference of -2% with approximate confidence limits of -24% to +19%.

ANAESTHESIA ON MASK - Loesser et al (1976) have shown the fact that a mask technique is followed by sorethroat is usually ascribed to the drying of mucous membrane after ventilation with dry gases and to the use of anrtisialogogues.

INFECTION - Infection in the postoperative period remains a formidable problem. The altered respiratory defence mechanism and impaired mucociliary clearance, is reported to be the cause of frequent respiratory tract infection after general and topical anaesthesia (Corsen 1973). Salivary and other upper respiratory tract secretions contain vast number of commercial bacteria, some of these are potential pathogens (Cruickshank R. 1968). Transmission of infection through anaesthetic equipment remains a distinct possibility (Joseph 1952, Kunds et al 1962, Jain et al 1980). As such respiratory infection in the postoperative period, is probably caused by commercial bacterial flora acting as pathogens due to changes in the local defence mechanism produced by anaesthetic agents used.

HISTOPATHOLOGICAL CHANGE IN LARYNX AND TRACHEA AFTER ENDOTRACHEAL INTUBATION

Histopathological changes in larynx and trachea after endotracheal intubation were noted. Endotracheal intubation with cuff tube cause histopathological changes in trachea and larynx more early than plain tubes (Kriplani T.C., B.P. Singh Chansoriya, I.J.A.). Same author noted on experimental animals that changes are more severe under ether anaesthesia and least with trichloro-ethylene, with halothane, gas+oxygen and

methoxy-flurane in between.

Chansoriya et al (I.J.A.) noted that in ether group the most striking difference has been increased degree of cellular oedema, besides this the trachea as a whole was soft in all three dogs, have studied. They postulated that if the same type of softening and oedema can be postulated in smaller bronchioles, it can initiate patchy atelectasis.

It has been suggested that all changes observed by author are transient and complete recovery occurs as a rule. The process of recovery ^{starts} soon after extubation and is complete within a week (Hilding and Hilding 1962). But alongwith other incriminating factors like hypoxya, hypercarbia, shock, infection, prolonged duration, lack of humidification etc. these changes may not heal properly and lead to other severe sequelae.

Changes under ether were maximum and possibility of further sequelae and pulmonary atelectasis have been envisaged. (Chansoriya et al I.J.A.) changes seen under ether doubt its use as sole anaesthetic agent for longer duration.

Lindhotni (1969) noted that if assisted respiration is done, this causes movement of tube along the longitudinal axis resulting in more rubbing of the tube against the epithelium.

Intrusion of oversize tube is known to cause ulceration and severe damage of trachea within an hour (Way and Sooy 1965).

Chansoriya et al (I.J.A.) noted on experimental animals, mild ischaemia at cuff site is due to pressure exerted by inflated cuff, congestion observed above and below the cuff has been attributed to impedance of venous drainage of the area due to increased pressure in the cuff as compared to the mean venous capillary pressure (Smith Knowson and Bassett 1974).

MATERIAL AND METHODS

M A T E R I A L A N D M E T H O D

The present study was carried out on 160 patients of either sex of A.S.A. Grade I and II at M.L.B. Medical College Hospital, Jhansi coming in for various routine surgeries.

SELECTION OF THE PATIENTS -

CRITERIA - The patients selected were those exhibiting the following criteria -

1. Patients exhibiting upper respiratory tract infection and other respiratory problems, were excluded from the study.
2. They should not have had a nasogastric tube passed within one week preceding operation.
3. The selected cases must require oral intubation only.
4. Patients must have a free and unobstructed airway so as to facilitate easy and smooth intubation.
5. Patients coming in for any oro-/naso-pharyngeal procedure were not included in the study.
6. Any type of pharyngeal instrumentation other than laryngoscope and tracheal tube was a discredit to the selection for study.
7. Patients taking drugs which can alter the incidence of sorethroat, were also excluded from the study.

GROUPING - After selection, the patients were divided into following groups -

A- CONTROL CASES - Where anaesthesia was administered by mask only.

B- The patients in this group were intubated by a cuffed or plain oro-tracheal tube. It was further subdivided into 4 groups as follows-

- | | | | |
|------|-------------|---|---|
| I) | Plain tube |) | Unlubricated |
| II) | Cuffed tube |) | |
| III) | Plain tube |) | Lubricated by 0.9% sterile normal saline. |
| IV) | Cuffed tube |) | |

Cuff used is high volume, low pressure type.

- | | | | |
|-----------------------|--|---|--------------------------|
| <u>MATERIAL</u> | Red rubber |) | |
| 1. Endotracheal tubes | White rubber |) | both cuffed and uncuffed |
| | P.V.C. |) | |
| 2. | Laryngoscope (Macintosh) | | |
| 3. | Boyle's 'F' anaesthesia machine | | |
| 4. | Laryngeal mirror, for indirect laryngoscope postoperatively. | | |
| 5. | Drugs-Atropine, Thiopentone Sodium, Suxamethonium Ether 0.9% normal saline, glutaraldehyde (cidex) solution 2%, 0.1% chlorhexidine in 70% alcohol. | | |

STERILIZATION - Endotracheal tubes and Magill's attachment of the boyle's machine were first cleaned with soap and water using brush and then immersing the same in cidex solution 2% for 30 minutes. Endotracheal tubes were used after washing thoroughly with water again.

Laryngoscope blade and endotracheal connections were sterilized by chemical sterilization using 0.1% chlorhexidine in 70 percent alcohol for 20 minutes.

PREPARATION OF THE PATIENT - Every selected patient was thoroughly examined both physically and systematically, giving special attention to upper and lower respiratory infection and any respiratory problem.

PREMEDICATION - 0.01-0.02mg/kg body weight injection atropine 1/M 45 minutes before operation.

ANAESTHESIA - Selected patients were given general anaesthesia by inducing with injection Thiopentone Sodium 3-4mg/kg and succinylcholine 1-1.5mg/kg then 100% oxygenation was given by mask and patient were intubated atraumatically with wide bore, Magill's selected Endotracheal tube, during direct laryngoscopy the larynx and oral cavity were again viewed for any inflammation and redness or congestion. No oropharyngeal air way was used.

Patients were maintained on oxygen, nitrous-oxide & ether, duration of intubation was minimum of 60 minutes. During extubation larynx and oral cavity was again viewed by direct laryngoscopy.

Control cases were administered anaesthesia by mask using oxygen, nitrous-oxide and ether.

POSTOPERATIVE FOLLOWUP - Patients ^{were} followed up post-operatively upto one week. During followup patients were interrogated about symptoms of sorethroat viz. soreness, scratchy feeling in throat and/or hoarseness. Patient's oral cavity and larynx were viewed by laryngeal mirror after 24 hour of operation, on 3rd day and 7th day and any redness, congestion, oedema and ulceration were noted. Both subjective and objective findings by laryngeal mirror were noted and accordingly graded from 0-3 depending upon the severity of the problem-

- 0- No sore or scratchy throat at any time since operation and no evidences of hoarseness at the time of interview.
- 1. Minimal sore or scratchy throat for the same period and no hoarseness at the time of interview.
- 2. Moderate sorethroat and/or some hoarseness.
- 3. Severe sorethroat for the same period and/or obvious hoarseness at the time of interview.

OBSERVATION AND RESULTSTABLE - 1AGE/SEX DISTRIBUTION OF THE PATIENTS STUDIED

INCIDENCE OF SORETHROAT ACCORDING TO AGE AND SEX OF THE PATIENTS:-

Age Group (Years)	TOTAL CASES				SORETHROAT PRESENT			
	MALE		FEMALE		MALE		FEMALE	
	No.	%	No.	%	No.	%	No.	%
0-10	12	14.45	7	14.58	5	41.66	5	71.40
11-20	12	14.45	6	12.50	5	41.66	4	66.67
21-30	12	14.45	7	14.58	5	41.66	4	66.67
31-40	12	14.45	7	14.58	5	41.66	5	71.40
41-50	12	14.45	7	14.58	4	33.34	4	66.67
51-60	11	13.25	7	14.58	4	33.34	4	66.67
61-70	12	14.45	7	14.58	5	41.66	4	66.67
	83	63.35	48	36.65	33	39	30	61

Above table shows that 33 out of 83 male patients exhibited sorethroat as against of 30 of 48 female patients, showing a higher incidence of sorethroat in female patients (61%) as compared to male patients (39%).

TABLE - 2

INCIDENCE OF SORETHROAT AMONG MASK AND INTUBATED GROUP

GROUP	TOTAL NUMBER STUDIED	<u>SORETHROAT PRESENT</u>		<u>SORETHROAT ABSENT</u>	
		No.	%	No.	%
1. MASK GROUP	29	10	34.5	19	65.5
2. INTUBATED GROUP	131	63	48	68	52

1. Above table throws light on incidence of sorethroat in control group. Out of 29 patients in mask group 10 patients complained of sorethroat giving an incidence of 34.5%.

2. Out of total cases of 160 patients, 131 patients were in intubated group and in it, 63 patients exhibited sorethroat postoperatively giving an incidence of sorethroat 48%.

TABLE - 3

DISTRIBUTION OF PATIENTS ACCORDING TO THE GRADE OF SORETHROAT
AMONGST INTUBATED PATIENT

GRADE	NUMBER	PERCENTAGE
0	68	52
I	22	16.8
II	23	17.5
III	16	13.7

Above mentioned table showed that sorethroat in intubated group is present in 48%, out of which 17.5% of Grade II, 16.8% of Grade I and 13.7 of Grade III.

TABLE - 4
COMPARISON OF INCIDENCE OF SORETHROAT WITH DIFFERENT
GROUP OF TUBES

GROUP	<u>SORETHROAT PRESENT</u>		<u>SORETHROAT ABSENT</u>	
	No.	%	No.	%
I-PLAIN LUBRICATED	4	13.8	25	86.2
II-PLAIN UNLUBRICATED	24	72.72	09	27.27
III-CUFFED LUBRICATED	20	29.4	24	70.6
IV-CUFFED UNLUBRICATED	25	71.43	10	28.57

(1) This table indicates the highest incidence of sorethroat in plain unlubricated group that is 72.72% and lowest incidence in plain lubricated group that is 13.8%, showing the effect of lubrication.

(2) Incidence of sorethroat in cuffed unlubricated group is 71.43% as opposed to 29.4% in cuffed lubricated group, indicating again the effect of lubrication.

(3) Incidence of sorethroat in plain lubricated group is 13.8% while in cuffed lubricated group it is 29.4%, giving the effect of cuff on incidence of sorethroat.

TABLE - 5
INCIDENCE OF SORETHROAT WITH DIFFERENT TYPES OF MATERIAL
OF TUBE

MATERIAL OF TUBE	SORETHROAT PRESENT		SORETHROAT ABSENT	
	No.	%	No.	%
I-WHITE RUBBER (41)	17	41.4	24	58.6
II-RED RUBBER (56)	26	46.4	30	53.6
III-P.V.C. (34)	20	58.7	14	41.3

Above table shows the highest incidence of sorethroat in the P.V.C. group that is 58.7%.

Incidence of sorethroat in red rubber group is greater than white rubber group, 46.4% in red rubber group as against 41.4% in white rubber group.

TABLE - 6
**INCIDENCE OF SORETHROAT WITH DIFFERENT TYPE OF NONLUBRICATED
 PLAIN TUBES**

INTUBATED GROUP	TOTAL	GRADE OF SORETHROAT							
		0		I		II		III	
		No.	%	No.	%	No.	%	No.	%
I-WHITE RUBBER	05	2	40	1	20	1	20	1	20
II-RED RUBBER	20	5	25	3	15	8	40	4	20
III-P.V.C.	08	2	25	1	12.5	2	25	3	37.5
TOTAL	33	9		5		11		8	

(1) Above table shows that out of 5 patients in white rubber plain unlubricated group, 3 patients exhibited sorethroat, on each of Grade I, II and III giving an incidence of sorethroat in 60%.

(2) The 15 patients showed sorethroat of varying Grade out of 20 patients studied in red rubber plain unlubricated group giving an incidence of 75%.

(3) The 6 patients complained of sorethroat post-operatively, in 8 patients studied in P.V.C. plain unlubricated group giving 75% incidence of sorethroat.

TABLE - 7

INCIDENCE OF SORETHROAT WITH DIFFERENT TYPES OF LUBRICATED
PLAIN TUBES

INTUBATED GROUP	TOTAL	GRADE OF SORETHROAT							
		0		I		II		III	
		No.	%	No.	%	No.	%	No.	%
I-WHITE RUBBER	08	7	87.5	0	0	1	12.5	0	0
II-RED RUBBER	15	13	86.67	1	6.67	0	0	1	6.66
III-P.V.C.	06	05	83.33	0	0	0	0	1	16.67
TOTAL	29	25		1		1		2	

(1) Out of 8 patients studied in white rubber plain lubricated group, only one patient complained of moderate degree giving an incidence of 12.5%.

(2) The 15 patients studied in red rubber plain lubricated group, 2 patients exhibited sorethroat, one of mild and other of severe grade, giving an incidence of 13.33%.

(3) Only one patient exhibited sorethroat of severe degree, out of 6 patients studied in P.V.C. plain lubricated group giving an incidence of 16.67%.

TABLE - 8

INCIDENCE OF SORETHROAT WITH DIFFERENT TYPES OF LUBRICATED
CUFFED TUBE

INTUBATED GROUP	TOTAL	GRADE OF SORETHROAT							
		0		I		II		III	
		No.	%	No.	%	No.	%	No.	%
I-WHITE RUBBER	12	9	75.0	1	8.3	1	8.3	1	8.3
II-RED RUBBER	11	8	72.7	1	9.2	2	18.1	0	0
III-P.V.C.	11	7	63.6	0	0	2	18.18	2	18.18
TOTAL	34	24		2		5		3	

(1) Out of 12 patients in white rubber cuffed lubricated group 3 patients complained of sorethroat one each of grade I, II and III, giving 24.9% incidence of sorethroat.

(2) The 3 patients exhibited sorethroat in red rubber cuffed lubricated group out of 11 patients studied giving an incidence of sorethroat in 27.3%.

(3) The 11 patients studied in P.V.C. suffed lubricated group 4 patients exhibited sorethroat giving an incidence of sorethroat of 36.36%.

TABLE - 9

INCIDENCE OF SORETHROAT WITH DIFFERENT TYPE OF NONLUBRICATED
CUFFED TUBE

INTUBATED GROUP	TOTAL	GRADE FO SORETHROAT							
		0		I		II		III	
		No.	%	No.	%	No.	%	No.	%
I-WHITE RUBBER	16	6	37.5	2	12.5	4	25.0	4	25
II-RED RUBBER	10	4	40	2	20	2	20.0	2	20
III-P.V.C.	09	0	0	2	22.22	2	22.23	5	55.55
TOTAL	35	10		6		8		11	

- (1) The 10 patients exhibited sorethroat out of 16 patients studied in white rubber cuffed unlubricated group giving an incidence of 62.5%.
- (2) Out of 10 patients in red rubber cuffed unlubricated group 6 patients exhibited sorethroat of varying grade with incidence of sorethroat of 60%.
- (3) Out of 9 patients studied in P.V.C. cuffed unlubricated group, all patients exhibited sorethroat giving an incidence of sorethroat of 100%.

TABLE - 10

TABLE SHOWING POSTOPERATIVE FINDING ON INDIRECT LARYNGOSCOPY

I/L FINDING	No.	%
REDNESS	24	18.30
CONGESTION	21	16.00
OEDEMA	18	13.70
ULCERATION	0	0

Above table given an idea about the finding of indirect laryngoscope postoperatively. Ulceration was not found in any case, while Redness, Congestion and Oedema were observed in 18.30%, 16.00 and 13.70 respectively.

DISCUSSION

DISCUSSION

Endotracheal intubation has been known for long time and has firmly established its place in modern anaesthetic practice and also in resuscitation. Apart from so many glittering gains, that it provides, endotracheal intubation is also associated with several major and minor complications and side effects.

Minor sequelae of endotracheal intubation include postoperative sorethroat, is still the problem. True etiology to this common problem has so far been eluding the present anaesthetist although several factors have been blamed as possible culprits.

Etiology of postoperative sorethroat is still not clear but numerous factors have been known responsible like infection, reaction to the material of tube, dry gases, local anaesthetics, lubricants, pressure of tubal cuff etc. Contributory factors blamed are unsterilized endotracheal tube, trauma by laryngoscope, pharyngeal airway, pharyngeal throat gauze packing, ryle's tube, type of muscle relaxant used for intubation, skill of anaesthetics, difficult intubation, extent of movement of patient's head after intubation etc.

So the present study is carried out to know the effect of various types of endotracheal tubes, effect of lubrication (normal saline 0.9%) and effect of cuff

(high volume low pressure) on incidence of postoperative sorethroat. The 160 in-patients were studied of either sex and of each group ranging from 5-70 years coming for various routine surgeries of A.S.A. Grade I & II only.

Patients were divided into two groups as mentioned earlier and minimum duration of anaesthesia was 60 minutes. Inhalational agent used in each patient was ether. Each selected patient was interrogated postoperatively about sorethroat and examined by laryngeal mirror upto one week for any evidence of laryngotracheitis and graded according to severity of sorethroat.

AGE/SEX DISTRIBUTION

Higher incidence of postoperative sorethroat has been reported in females (Wolfson 1958, Hortsell & Stephen 1964, Jensen et al 1982, Shah & Mapleson 1984, Gard and Cruick shank 1961). Table no. 1 indicates higher incidence of sorethroat in females (61%) as compared to males (39%). There is no difference in age on incidence of postoperative sorethroat. Possible explanation for higher incidence in females is high cuff tracheal contact area and more tendency of contact ulcer and granuloma formation due to difference in anatomical conformity of trachea in females.

GROUP A (MASK GROUP) -

Loeser et al (1976) have shown the fact that Mask technique is followed by sorethroat is usually due to the drying of mucous membrane after ventilation with dry gases, to the irritant property of inhalational agent and to the use of antisialogogues.

Table 2 indicates that out of 160 patients studied, 29 patients were given anaesthesia by mask, out of which 10 patients developed sorethroat giving an incidence of sorethroat 34.5%. This is taken as control cases. The fact that mask technique is followed by sorethroat is ascribed to the drying of mucous membrane of larynx and trachea and irritant property of ether.

GROUP B (INTUBATED GROUP) -

Infection in the postoperative period remains a formidable problem. The altered defence mechanism and impaired mucociliary clearance is reported to be the cause of frequent respiratory tract infection after general and topical anaesthesia (Corsen 1973). Salivary and other respiratory tract secretions contain vast numbers of commercial bacteria, some of these are potential pathogens (Cruickshank, R. 1968) transmission of infection through anaesthetic equipment remains a distinct possibility (Joseph 1952, Kund et al 1962, Jain 1980). As such

respiratory infection in the postoperative period is probably caused by commercial bacterial flora acting as pathogens due to changes in the local defence mechanism produced by anaesthetic agents used.

Histopathological changes in trachea and larynx were reported more early with cuffed tube than with plain tubes (Kriplani T. C., B.P. Singh, Chansoriya I.J.A). same authors noted on experimental animals that changes are more severe under ether anaesthesia and least with trichloroethylene, with halothane, gas+oxygen and methoxy flurance in between.

Table 2 shows that 131 patients were given anaesthesia through endotracheal tubes, out of which 63 patients developed sorethroat of varying severity giving an incidence of 48%. Possible explanations for development of sorethroat, are altered defence mechanism of upper and lower respiratory tract following anaesthesia and ciliostasis, mucociliary impedance leading to more chances of infection due to both endogenous (normal bacterial flora) and exogenous (transmitted via anaesthetic machine) and also due to mucosal erosion caused by ischaemia and pressure necrosis of tracheal mucosa caused by orotracheal tube and its cuff leading to development of postoperative laryngotracheitis. Ether as irritant to tracheal mucosa and effect of antisialogogues (Atropine) used may be contributory factor in increasing postoperative sorethroat in intubated group.

MATERIAL OF TUBE -

The effect of the material of the tube on postoperative sorethroat, is controversial. Shah and Mapleson (1984) reported higher incidence of sorethroat with red rubber tubes than with P.V.C. tubes whereas Jensen and Colleagues (1982) have shown higher incidence with P.V.C. tubes.

Table nos. ~~5-9~~ 5, (6-9) indicates higher incidence of sorethroat in P.V.C. tubes followed by red rubber and white rubber in that decreasing order. In white rubber tubes incidence is 41.4%, in red rubber tubes it is 46.4% and in P.V.C. tubes 48.7%, cause of this difference is not clear, probably it may be due to difference in composition of material of tubes leading to difference in reaction with tracheal mucosa and/or inhalational agent (ether) used.

EFFECT OF LUBRICATION -

Various workers have studied effects of lubricants using normal saline, lidocaine viscous, jelly, cream, ointment and suggested different views regarding their use. Creams are generally more desirable than jellies, because jellies tend to dry out quickly and become hard and sticky on the endotracheal tubes when applied any length of time prior to operation (Gard & Cruickshank 1961).

Conway et al (1960) reported that cinchocaine 1% ointment was associated with high incidences of sorethroat but Winkel and Knudsen (1971) have shown that patient might benefit from lubrication of tracheal tubes with 1% cinchocaine jelly. Conway et al (1960) have given possible explanation that greasy base of the preparation might dissolve some irritant substance from the rubber of endotracheal tube.

So varying are the results of lubrication that Jensen et al (1982) suggested lubrication of tracheal tubes provide no advantage in terms of reducing sorethroat after operation.

On the other hand Loeser, Stanley et al (1980) reported that lubrication with 4% lignocaine jelly containing polyethylene and propylene glycol was associated with increased complaints after operation.

Christine Stock and Downs (1980) studied the effect of lubrication of endotracheal tubes with many lubricants which include water soluble jelly, normal saline solution, lidocaine 2% jelly and lidocaine $2\frac{1}{2}\%$ ointment. They concluded that sorethroat and hoarseness occurred to the same extent as those who received non-lubricated tubes. Lidocaine present in lubricants do not appear to decrease incidence of sorethroat.

So controversial is the effect of lubrication that many investigators have reported that intubation was mechanically easier when some form of lubrication was applied to the tube.

Method of lubrication used in the present study is sterile normal saline 0.9%. Incidence of sorethroat with lubricated group, both with plain and cuffed tubes was lower than unlubricated group (Table no. 4 (6-9)). In plain lubricated group incidence of sorethroat is 17.8% as compared to plain unlubricated tube in which an incidence as high as 72.7% was achieved. Likewise the incidence of sorethroat in cuffed lubricated group is 29.4% as compared to cuffed unlubricated group where it is 71.43% (Table no. 4 (6-9)).

In this study normal saline 0.9%, as lubricant appear to be the agent which has decreased the incidence of sorethroat. The reason for this may be isotonicity of normal saline making homeostasis constant and no reaction with the material of tube and mechanical advantage of lubrication with normal saline.

EFFECT OF CUFF -

Effect of endotracheal cuff on incidence of postoperative sorethroat has been studied by several workers from time to time and they have given controversial result

regarding its effect. Although cuff anchors the tubes and thereby decreases movement of tube with-in trachea but cuff can cause mucosal erosion of trachea leading to post-operative sorethroat. More so, when cuff is inflated to beyond the just seal point it causes pressure necrosis leading to postoperative sorethroat. Nitrous-oxide has the ability to diffuse into cuff and so causing the over-expansion of cuff leading to increased pressure necrosis of tracheal mucosa (Stanley et al 1974, 1975 & 1978).

Cuff tracheal contact area is, an important factor in the development of postoperative sorethroat. Many authors have studied this fact. High volume low pressure cuff caused higher incidence of postoperative sorethroat than high pressure low volume cuff (Stanley et al 1978, Loeser et al 1980, Erikenson, Jensen et al 1982, Shah and Mapleson 1984). Possible explanation given are (1) That many large volume cuff wrinkles inspite of proper inflation and wrinkles result in a deep mucosal grooves. (2) Tracheal mucosal membrane or ciliary damage in direct relation to the cuff tracheal wall contact area. (3) Bulkier and larger low pressure tubes produce more damage to upper airway structures on intubation or extubation (Loeser, Modges et al 1978, Jensen et al 1982).

But when intra-cuff pressure in low volume high pressure cuff tube was high and allowed to increase, the advantage of low cuff tracheal contact area disappeared (Erikensen, Jensen et al 1982).

Type of cuff used in the present study was high volume, low pressure and cuff is inflated to just seal point with room air.

In this work incidence of sorethroat in plain lubricated tube is 13.8% as compared to 29.4% in cuffed lubricated tube (Table no. 4) showing the effect of cuff on incidence of sorethroat.

Explanation for above result may be that tracheal cuff produce more damage to tracheal mucosa or ciliary activity in direct relation to the cuff tracheal wall contact area leading to ciliostasis, mucociliary impedance, stagnation of secretions, ischaemia and pressure necrosis of tracheal mucosa leading to altered defence mechanism of tracheal mucosa giving good ground for the development of infection, thereby causing laryngotracheitis in postoperative period.

Hence in the end it can be concluded that the use of plain white rubber tube lubricated with 0.9% sterile normal saline would provide minimum incidence of postoperative sorethroat.

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 CONCLUSION

CONCLUSION

After the study on 160 patients and analysis of the data obtained, following conclusion was derived at :-

1. Incidence of postoperative sorethroat is higher in females than in males (61% in females, 39% in males).
2. In intubated group higher incidence of postoperative sorethroat is reported than in mask group (34.5% in mask group, 48% in intubated group).
3. Higher incidence is noted in P.V.C. group followed by red rubber and white rubber tubes in that order (48.7% in P.V.C. tubes, 46.4% in red rubber tubes, 41.4% in white rubber tubes).
4. In lubricated group, less patients exhibited postoperative sorethroat than in unlubricated group showing that 0.9% normal saline decreases the incidence of postoperative sorethroat (13.8% in plain lubricated group and 72.7% in plain unlubricated group, 29.4% in cuffed lubricated and 71.43% in cuffed unlubricated group).
5. High volume low pressure cuff used in the present study has increased the incidence of postoperative sorethroat (13.8% in plain lubricated tubes and 29.4% in cuffed lubricated tubes).
6. Incidence as well as severity of postoperative sorethroat is higher in P.V.C. group tubes.

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Endotracheal intubation is now the accepted technique for general anaesthesia and resuscitation.

Although this technique is unanimously accepted, it is associated with several major and minor complications and sequelae. The commonest sequelae is the occurrence of postoperative laryngotracheitis following endotracheal intubation.

Postoperative sorethroat was reported as early as 1950 (Wylie), following which numerous workers have studied about this problem (Baron and Kohlmoos 1951, Conway et al 1960, Hortsell et al 1964, Loeser et al 1976, Erikinsen et al 1980, Shah and Mapleson 1984), yielding conflicting results.

Several workers have reported controversial views regarding the effect of lubrication on the incidence of postoperative sorethroat (Winkel and Knudsen 1971, Loeser, Stanley et al 1980, Christine Stock 1980, Lund and Daos 1965). Many investigators have concluded that intubation was mechanically easier when some form of lubrication was applied to the tube.

High volume low pressure cuff causes higher incidence of sorethroat than low, volume high pressure cuff provided that intracuff pressure is inflated to just the

seal point and pressure is not allowed to rise. (Stanley et al 1974, 1975, 1978, Loeser et al 1980 Erikinsen, Jensen et al 1982, Shah and Mapleson 1984.

Conflicting results were noted about material of tube on the incidence of postoperative sorethroat. Shah and Mapleson (1984) have shown a non significant lower incidence with P.V.C. tubes than with red rubber tubes, whereas Jensen and Colleagues (1982) found a nonsignificant higher incidence with P.V.C. tubes.

It was therefore thought worthwhile to study the effect of various types of endotracheal tubes on the incidence of postoperative sorethroat and to see whether different materials have any effect on the incidence or not, as also its modification by lubrication and tubal cuffs.

The present study was conducted on 160 selected patients at the M.L.B. Medical College Hospital, Jhansi, over a period of one year.

Every selected patient was thoroughly examined both physically and systematically. No oral instrumentation was used other than laryngoscope, sterilized endotracheal tubes and anaesthetic equipment were used. Selected patients were given general anaesthesia after premedicating with 0.01-0.02 mg/kg body weight injection Atropine 45 minutes before operation. Patients were induced with injection

Thiopentone sodium 3-4 mg/kg and succinylcholine 1-1.5 mg/kg, then 100% oxygenation were given by mask and patients were intubated atraumatically. During direct laryngoscopy the larynx and oral cavity were again viewed for any inflammation, redness or congestion.

Patients were maintained on oxygen, nitrous-oxide and ether. The duration of intubation was minimum of 60 minutes. ~~During~~^U extubation larynx and oral cavity was again viewed by direct laryngoscopy. Control cases were administered anaesthesia by mask using oxygen, nitrous-oxide and ether.

Patients were followed up postoperative upto one week. During follow-up patients were interrogated about symptoms of sorethroat and examined by laryngeal mirror for any evidence of redness, congestion, oedema and ulceration in larynx and trachea and graded from 0-3 depending upon the severity of the problem. Patients were divided into two groups viz. mask group and intubated group, method of lubrication used was 0.9% sterile normal saline and both cuffed (high volume low pressure) and uncuffed tubes were used.

After the study on 160 patients and analysis of the data obtained following conclusion was derived at-

- 1- Incidence of postoperative sorethroat is higher in females than in males (61% in females, 39% in males).

- 2- In intubated group higher incidence of postoperative sorethroat is reported than in mask group (34.5% in mask group 48% in intubated group).
3. Higher incidence is noted in P.V.C. group followed by red rubber and white rubber tubes in that order (48.7% in P.V.C. tubes, 46.4% in red rubber tubes, 41.4% in white rubber tubes).
4. In lubricated group less patients exhibited post operative sorethroat than in unlubricated group showing that 0.9% normal saline decreases the incidence of postoperative sorethroat (13.8% in plain lubricated group and 72.7% in plain unlubricated group. 29.4% in cuffed lubricated and 71.47% in cuffed unlubricated group).
5. High volume low pressure cuff used in the present study has increased the incidence of postoperative sorethroat (13.8% in plain lubricated tubes and 29.4% in cuffed lubricated tubes).
6. Incidence as well as severity of postoperative sorethroat is higher in P.V.C. group tubes. Hence in the end it can be concluded that the use of plain white rubber tubes lubricated with 0.9% sterile normal saline would provide minimum incidence of postoperative sorethroat.
